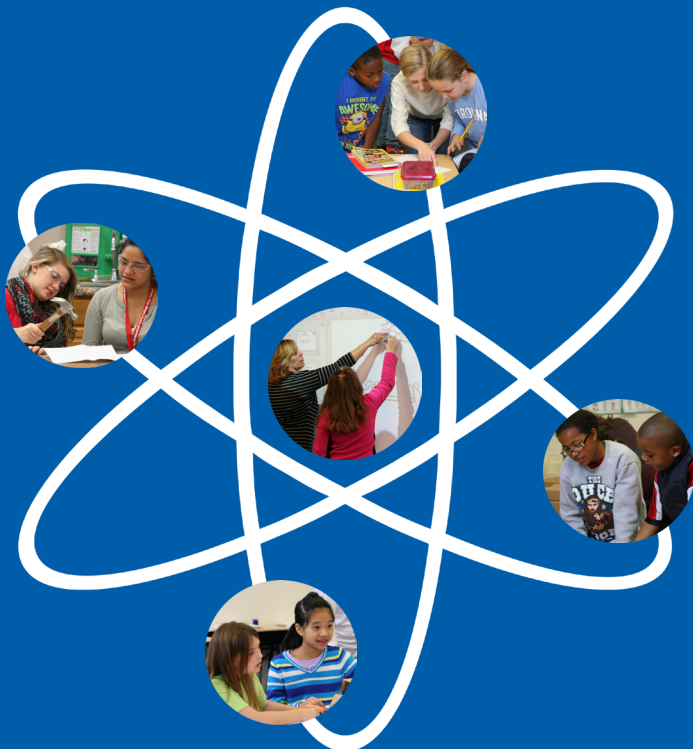


Moving Forward: State Engagement with the Next Generation Science Standards



Introduction to Next Generation Science Standards



rigorous K-12 science education builds student knowledge in core scientific content and equips students to analyze problems, use evidence, and investigate solutions. The education requirements of careers across the economy are increasing and all students – regardless of whether they pursue science as a career – need greater proficiency in the knowledge and practice of science to be fully ready for college and the workforce.

A coalition of states joined forces from 2011 to 2013 to develop a new set of science standards, the *Next Generation Science Standards* (NGSS), which outline what it means to be fully college and career ready in science. These standards are internationally benchmarked and draw from the practices of the highest-performing countries on international assessments, such as Singapore, Finland, Korea, Canada, and Japan. The NGSS are structured so that students are asked to engage in hands-on practices as they learn subject-based content; through an emphasis on cross-cutting concepts, the standards also build students' knowledge of ideas that apply across science disciplines. The standards follow a clear developmental progression so that knowledge builds logically from kindergarten through twelfth grade.

The *Framework for K-12 Science Education*, developed by the National Research Council and published in July 2011, forms the basis for the structure and scientific content of the NGSS. The *Framework* presents three key dimensions that are incorporated in each of the science standards:

- *Practices*: Behaviors scientists engage in as they investigate and build models and theories, as well as the practices engineers use as they design and build models and systems.

- **Cross-Cutting Concepts:** Concepts that help to link different domains of science, including patterns, similarity and diversity, cause and effect, and systems and system models.
- **Disciplinary Core Ideas:** The subject-specific content of the *Framework* focused on four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science

Twenty-six states voluntarily joined the process to develop science standards based on the *Framework*. A writing team was convened, comprised of 41 members from 26 states and representing K-12 and postsecondary education, as well as the scientific, engineering, and business communities. The states reviewed drafts of the standards and provided ongoing feedback to the writing team. Feedback from the public also was actively sought and incorporated through two public review periods in May and June 2012 and again in January 2013. In April 2013, the final set of NGSS were released and made available for states to adopt.¹

As of March 2014, 11 states¹ and the District of Columbia have officially adopted the NGSS, and each state is now developing its own implementation strategy. The case studies in this document provide a closer look at the strategies four states utilized through the NGSS writing and review process. The first two states, **Rhode Island** and **California**, have officially adopted the standards and are currently in the process of developing implementation plans. **Minnesota** and **North Carolina** were involved as lead states in the NGSS development process and provide useful examples of how state leaders are paving the way for a more rigorous K-12 science education.

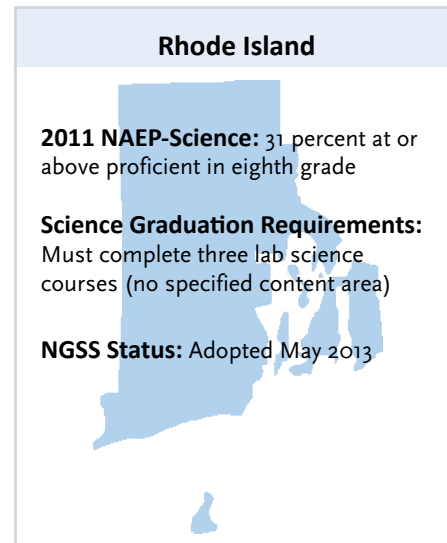
¹ California, Delaware, Illinois, Kansas, Kentucky, Maryland, Nevada, Oregon, Rhode Island, Vermont, and Washington

RHODE ISLAND

Background

Rhode Island's science standards were last updated and adopted in 2006. The state requires standards to be revised every five years, but the latest revision process was put on hold in anticipation of the NGSS.

Science content in Rhode Island has been assessed through the *New England Common Assessment Program* (NECAP), an assessment consortium that includes Maine, New Hampshire, Rhode Island, and Vermont. NECAP includes reading and math assessments for third through eighth grade and eleventh grade; writing assessments for fifth, eighth, and eleventh grades; and science assessments for fourth, eighth, and eleventh grades. The tests incorporate a variety of response types, including multiple choice, short-answer, and constructed response (essay). The science assessments in fourth and eighth grade also include hands-on activities that require students to conduct experiments and/or record observations. Rhode Island plans to participate in NECAP through 2016, after which point science will be assessed with an NGSS-specific test.



NGSS Participation and Development

Rhode Island was closely involved in the NGSS development from the beginning. The state organized committees of K-12 teachers and higher education leaders to participate in the 2010 review of the National Research Council's *A Framework for Science Education*, the foundation document for the NGSS. Given that state leadership had developed a strong understanding of, and appreciation for, the potential content of the new science standards, it made a decision to join the NGSS development process as a lead state partner.

One of the state's first actions was to establish the *Rhode Island State Leadership Team* (RISLT) for the Development of the Next Generation Science Standards. This 36-member state review team provided feedback to the NGSS writing team on multiple drafts of the standards. The RISLT included K-12 teachers, administrators, and college faculty from both arts and sciences and schools of education.

Recognizing the need to share information about the NGSS even before the final version was released, Rhode Island began a public communications effort in 2011. Beginning in August 2011 through April 2013, Rhode Island state leaders provided consistent communication about the NGSS to state stakeholders via e-mail listservs, Web sites, and presentations. Critical to the effort was the leadership of Peter McLaren, a Science and Technology Specialist at the Rhode Island Department of Education and member of the NGSS writing team. McLaren is Past President of the Council of State Science Supervisors; in that role, he implemented a national project for state science supervisors and state teams to develop a deeper knowledge and fluency in the content of the NRC *Framework*. **Rhode Island became the first state to adopt the NGSS after a unanimous vote by the State Board of Education on May 23, 2013.**

Implementation Plans

Given the complexity of these new standards, Rhode Island has decided to implement the NGSS over a four-year period. The 2013-14 academic year is focused on capacity building so that all Rhode Island educators understand the NRC *Framework* and the research behind the NGSS. The state is working to raise stakeholder awareness about the NGSS through presentations, webinars, and a dedicated Web site. The following years will focus on the re-design of NGSS-aligned curriculum, instruction, and assessments. Full implementation and assessment of the NGSS across all districts is expected by 2017-18.

Building NGSS Professional Development

The state is developing a robust professional development program around the NGSS through its *Building a Strong Foundation initiative*.ⁱⁱ The program was expanded by *Race to the Top* funds to bring greater instructional coherence by aligning curriculum, instruction, and assessments with state standards. Teachers and principals participate in multi-year cohorts to develop standards-based lessons and content sequences. Currently, a cohort of science teachers is doing a deep dive into the NRC *Framework* and the NGSS. These teachers will also develop model lesson plans in the second year of their cohort experience.

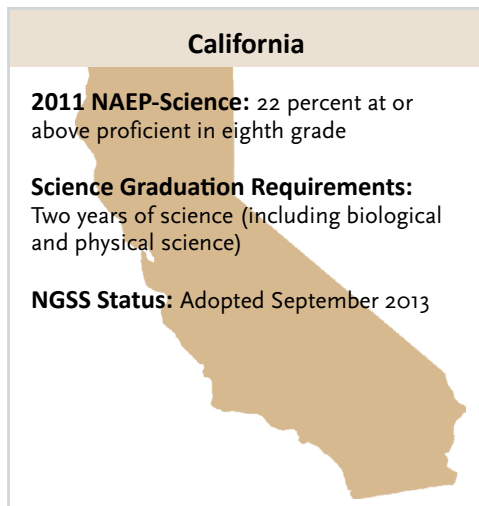
Rhode Island has also launched a grant program for school districts to build professional development around standards-based math and science practices. Those districts focusing on science will study the integration and intersection of scientific and engineering practices, cross-cutting concepts, and disciplinary core ideas. Participating higher education partners will develop and deliver summer and follow-up professional development. In 2013-14, teachers in the program will be videotaped as they deliver model lessons that were developed during summer training. These videos will be

used to highlight best practices, reflective thinking, and student growth in online modules that will be available to all of the state's teachers.

CALIFORNIA

Background

Prior to adopting the *Next Generation Science Standards* (NGSS), California had not revised its science standards since 1998. The previous standards were broken down by grade level for kindergarten through eighth grade; the high school standards were divided into earth science, biology/life science, physics, and chemistry. The state also previously had a separate set of investigation and experimentation standards for ninth through twelfth grade, which were designed to be taught in conjunction with the subject-specific high school science standards. The investigation standards were no longer needed upon the adoption of the NGSS given that the new standards integrate the practices of science with the core content.



Legislative Activity to Initiate Science Review Process

The process to update the *Science Content Standards* for California Public Schools began in 2011, when new legislation passed that required the state's science standards to be reviewed and revised based on the NGSS. The legislation provided a process to incorporate feedback from the general public and also the appointment of an expert panel to recommend a set of standards to the State Board of Education. Final science content standards were to be presented to the Board by March 2013, with a decision due by July 2013.

In 2012, an amendment, sponsored by the State Superintendent of Public Instruction Tom Torlakson and the California Department of Education (CDE), provided additional time given delays in the release of the final NGSS draft. The four-month postponement also allowed the state to gather additional feedback from teachers and stakeholders before the final standards were shared with the State Board of Education for action.

California Participation in NGSS Development

California served as one of the lead state partners during the development of the NGSS. As part of its involvement, Superintendent Torlakson convened a *State Review Team* to provide ongoing feedback to the NGSS writers. The California team was comprised of 80 individuals, including K-12 science teachers, administrators, county science consultants, higher education faculty, and business executives. During an 18-month process, the *State Review Team* reviewed five public and internal drafts of the NGSS and shared comments with the CDE and the standards writers.

After the last draft of the NGSS was released in January 2013, Superintendent Torlakson assembled a *Science Expert Panel* (SEP) consisting of a small group of representatives from the *State Review Team*. The SEP convened three times from April to June 2013 to review feedback from three regional public

meetings, a webinar, and public surveys. Upon the conclusion of its work, the SEP issued a final recommendation that the State Board adopt the NGSS. The new standards were also endorsed by the California Science Teachers Association and the California STEM Learning Network.

NGSS Adoption Process

The NGSS were presented to the California State Board of Education on July 10, 2013. After hearing presentations from the *Science Expert Panel* and the CDE, as well as numerous public comments, the board delayed its decision to allow teachers more time to review the standards. Two months later, the California State Board of Education unanimously voted to adopt the NGSS. The Board postponed a decision regarding the structure of middle grade science content to gather additional input from teachers, administrators, and other stakeholders.

California statute requires standards to be assigned to each grade level for kindergarten through eighth grade, and the previous California science standards had focused on earth science in sixth grade, life sciences in seventh grade, and physical sciences in eighth grade. The NGSS, on the other hand, are structured by grade span for middle school (sixth through eighth grade), and teachers would be expected to teach a combination of these subjects in each middle school grade.

Why Integrate Standards Across Grades?

Underlying the NGSS standards is the concept that spreading, or, “integrating” subject matter across grades can give students a more holistic understanding of how science concepts fit together. All of the top-performing countries in science also use integrated, rather than grade-level, science standards for middle and high school.ⁱⁱⁱ

The *Science Expert Panel* had unanimously recommended the integrated approach for sixth through eighth grade. However, the potential restructuring of middle school science content raised some concerns with teachers and administrators. Through the regional forums and the online survey sponsored by the *Science Expert Panel*, individuals expressed reservations about the availability of curriculum materials and whether adequate professional development exists for this different structure of middle school science content.^{iv}

In November 2013, the State Board of Education adopted the integrated model as the *preferred model* for middle school science. It also called for the *Science Expert Panel* to reconvene to develop an alternative subject-specific model for the middle grades, based on guidance provided by the NGSS writers in an appendix to the adopted standards. Districts will be able to select which model best meets their capacity and the needs of their students. Regardless of the model a district selects, all students will be expected to have mastered the same science content by the end of eighth grade.^v

Plans for NGSS Implementation

The CDE has identified three phases for NGSS implementation: Awareness (2013-15); Transition (2015-16); and Implementation (2016-17). Moving forward, the State Superintendent plans to appoint a *Strategic Leadership Team* to develop an overall implementation plan for the NGSS and related science frameworks and assessments.

The *California Science Framework* serves as a “blueprint” for how standards should be implemented in the classroom and includes guidelines for science pre-service training, instruction, professional development, and instructional materials.^{vi} Early efforts are currently underway to revise this *Framework* to align with the NGSS.^{vii} Four focus groups of teachers, scientists, and other

stakeholders have already met to discuss how the *Framework* should be revised to support effective instruction and implementation of the NGSS. A committee appointed by the State Board of Education will develop the new *Framework* through 2014-15, and after two rounds of public review, the State Board of Education will take action by January 2016.

Funding is already available to districts for professional development on the NGSS; the state budget signed by Governor Jerry Brown in June 2013 included \$1.25 billion in one-time funding to assist districts in implementing the Common Core State Standards, Next Generation Science Standards, and the California English Language Development Standards.

Legislation has also recently passed to overhaul the state's student assessment system. Science will still be assessed in fifth, eighth, and tenth grades through the 2013-14 academic year. The bill calls for new assessments based on the NGSS to be administered at least once in grades three through five, once in grades six through nine, and once in grades ten through twelve. Language in the bill also calls for the State Superintendent to submit a plan to the State Board of Education on strategies to assess science and other subjects in a variety of innovative ways, due by March 2016.^{viii}

NORTH CAROLINA

Background

North Carolina was involved as a lead state partner in the development of the *Next Generation Science Standards* (NGSS). The state has not yet adopted the NGSS, given the recent update of the state's science standards as part of a comprehensive update to the state's K-12 standards and assessments across all subjects.

North Carolina's *Science Essential Standards* were adopted by the State Board of Education in February 2010. These standards were developed based on a set of documents that includes the National Assessment of Educational Progress 2009 *Science Framework*, the College Board's *Science Standards for College Success*, National Science Teacher Association's *Science Anchors* initiative, the National Research Council's *National Science Education Standards*, and American Association for the Advancement of Science's *Benchmarks for Science Literacy*. The *North Carolina Science Essential Standards* are organized by grade level for kindergarten through eighth grade, and by courses in high school. These standards were adopted in February 2010, with full implementation beginning in the 2012-13 school year.

North Carolina

2011 NAEP-Science: 26 percent at or above proficient in eighth grade

Science Graduation Requirements:

Three credits of science, including physical science, biology, and environmental science

NGSS Status: NGSS not yet adopted

Setting the Stage for More Rigorous Scientific Practices

Through the NGSS development process, the Department of Public Instruction shared drafts as they became available with stakeholder groups including classroom teachers, business leaders, and college and university faculty. These individuals' feedback on the standards was then shared with the team responsible for writing the NGSS.

Given North Carolina's recent adoption of new state standards across all subject areas, including science, the state has not yet taken steps towards the adoption of the NGSS. Currently, the Department of Public Instruction is focused on supporting teachers on effectively transitioning to the *NC Essential Standards for Science*. However, a number of innovative science professional development programs in North Carolina are helping to train teachers in the type of rigorous, hands-on science modeled in the NGSS.

The North Carolina Department of Public Instruction has focused science professional development in the 2013-14 school year on building students' ability to use evidence in scientific reasoning and problem-solving. Its major summer professional development institute for school districts and charter schools introduced a claims-evidence-reasoning model for argument in K-12 science education. The aim is to also link to the careful reading and analysis students required by the Common Core State Standards.

Select rural school districts in North Carolina² are involved in an i3 grant to evaluate the National Science Resources Center's (NSRC) *Leadership Assistance for Science Education Reform* (LASER) model. The LASER program offers a systematic approach to science education reform with an emphasis on experiential, hands-on science learning. Both teachers and school leaders are receiving extensive professional development through the program.

² Program also includes the Houston Independent School District and districts in New Mexico.

Johnston County Schools are also undertaking a new professional development program in partnership with the Smithsonian Science Education Center and the North Carolina Science, Mathematics and Technology Education Center. Teachers from selected schools in Johnston County will participate in up to 90 hours of professional development designing model lessons that use Smithsonian Science kits based on the NGSS.

Efforts Underway to Strengthen Science Education

Efforts across North Carolina are also increasing cross-sector collaboration and support for stronger K-12 science education. Many of these programs include science as part of an overall strategy focused on STEM education. Leaders from North Carolina's legislative, business, and education communities have developed a *STEM Education Strategic Plan* to better coordinate and improve statewide and local STEM initiatives. The plan's goals include increasing student achievement in STEM fields, increasing the growth of high-quality programs and schools, and better aligning investments in STEM education across the public and private sector.^{ix}

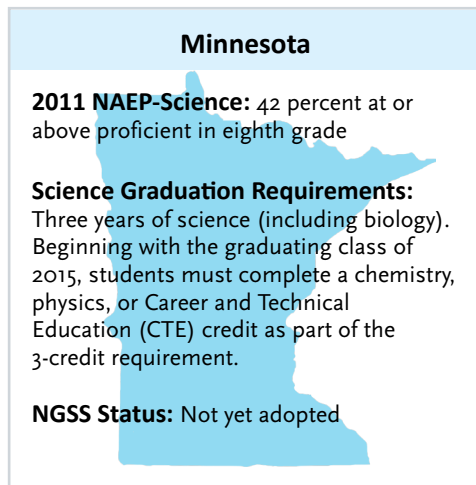
North Carolina is also working to expand innovative science learning opportunities through the development of new STEM-focused schools. *North Carolina New Schools* has been a leader in developing early-college high schools that graduate students with two years of university transfer credit or associate's degrees in addition to their high school diplomas. Today, *New Schools* is building on its work with innovative high schools to develop networks of schools focused on subjects tied to North Carolina's economic and workforce needs. These networks are focused around common growth industries in the state, including energy, health and life sciences, aerospace, and biotechnology and agriscience. In 2012, the 13 STEM-focused schools that were ongoing partners with *North Carolina New Schools* had a graduation rate of 95.3 percent.^x

In response to a shortage of teachers in science and STEM fields, a new, non-traditional teacher preparation program has also recently been launched in the state. The *North Carolina STEM Teacher Education Program* is a free, alternative licensing program for individuals interested in working as high school science, technology, engineering or math teachers. Program applicants are required to have a bachelor's degree in a science, technology, engineering, or mathematics related field. Following their training and a school-based internship, participants are required to complete a three-year commitment to teach in North Carolina. The first cohort of teachers will begin their training in fall 2014.^{xi}

MINNESOTA

Background

Minnesota recently adopted a new set of state science standards that were fully implemented and first assessed in the 2011-12 school year. Minnesota statute specifies that the next date for the revision of science standards will be in 2017-18; any changes to that date would require action by the state legislature and governor. The state was an active participant in the development of the *Next*



Generation Science Standards and gathered feedback from multiple stakeholder groups during the review process.

History of Strong State Science Performance

Minnesota is a state with a record of strong student achievement in science. On the 2011 *National Assessment for Educational Progress* (NAEP), Minnesota ranked 9th among all states for fourth-grade science, and ranked 7th in eighth-grade proficiency.

Minnesota has also participated in the *Trends in International Mathematics and Science Study* (TIMSS), which compares the international performance of fourth- and eighth-grade students in math and science. Among all of the participating countries and U.S. states in 2011, **only Singapore and Taiwan outperformed Minnesota in eighth-grade science.** Although Minnesota's overall science scores are above national and international averages, state leaders have also recognized that there are significant achievement variations among student groups. Only 10 percent of black eighth-grade students scored at or above proficient on the 2011 NAEP, whereas 49 percent of white students were proficient. This achievement gap was unchanged from the previous administration of the NAEP in 2009.

Reducing the achievement gap in STEM has been established as a priority of several initiatives in Minnesota. The *Minnesota Compass* project identifies key data measures from early childhood through career to evaluate the state's progress in addressing disparities in learning, including in STEM subjects.^{xii} *Minnesota's P-20 Education Partnership* includes key leaders from Minnesota's education, government, and business sectors and is chaired by the State Commissioner of Education. In 2011, a work group of the *Partnership* released a report outlining a statewide plan to close achievement gaps in STEM subjects. Its recommendations include developing grade-level assessments for all STEM disciplines; improving regional coordination of

STEM programs with businesses and higher education; and incorporating more STEM content and pedagogy in teacher preparation programs.^{xiii}

Current State Science Standards

The current *Minnesota Academic Standards* in Science were revised in 2009 and fully implemented in the 2011-12 school year. A committee of representatives from K-12 education, higher education, business, and the broader community met for a year to develop these standards. The committee consulted a series of documents for their work, including the *National Science Education Standards*, the *Benchmarks for Science Literacy*, the 2009 *NAEP Framework*, and the *Standards for Technological Literacy*. The draft standards were reviewed by national science and engineering experts, representatives from the *Minnesota P-20 Education Partnership*, as well as special education experts.

The standards are organized into four content strands: 1) Physical Science; 2) Earth and Space Science; 3) Life Sciences; and 4) the Nature of Science and Engineering. The inclusion of engineering marked a change from previous versions of the standards and was developed in recognition of the importance of integrating science with engineering practices. Students are expected to learn to engage in activities such as analyzing and interpreting data; developing and using models; planning investigations; and designing engineering solutions to problems throughout their subject-based science courses.^{xiv} The state also developed a highly-searchable Web site to support instruction for mathematics and science.^{xv}

Participation in NGSS Development

Minnesota provided feedback to the writers of the foundational document for the Next Generation Science Standards, the *Framework for K-12 Science Education* (NRC Framework). Minnesota also participated as a lead state in

the development of the NGSS. Three committees were organized as the state began to participate in the development process: a review team of teachers and higher education faculty from a variety of content areas; a committee of business leaders, community members, and advocacy organizations; and a committee focused on professional development. One of the members of the NGSS writing team was Mary Colson, a classroom earth science teacher and President of the Minnesota Science Teacher Association. Five focus groups were held across the state after the first draft of the NGSS was released to share about the standards and gather public input.

Building on NGSS Content to Strengthen Science Instruction

Although Minnesota is not scheduled to update its science standards until 2017, the state is already utilizing the ideas of the NRC *Framework* and the NGSS to support its current standards. The University of Minnesota co-hosted a conference in 2012 on building connections between science and engineering education. The keynote address was delivered by Heidi Schweingruber, one of the co-directors of the study that produced the NRC *Framework*. *SciMathMN*, a business and education partnership, held a policymaker briefing and a presentation to the legislature by Stephen Pruitt, the chief coordinator of the NGSS development effort. At the August 2014 Minnesota Assessment Conference, James Pellegrino, the co-chair of the NRC report *Developing Assessments for the NGSS* will speak on new developments in assessment of learning.

The Minnesota Department of Education has also focused its federal *Math and Science Partnership* funds on the cross-cutting concepts found in the NRC *Framework*. Partnerships of high-need districts and institutions of higher education that apply for grants must target their professional development plans for science teachers around cross-cutting concepts in the NRC *Framework* such as patterns, systems, and cause and effect. Minnesota is a pilot state for the *Next Generation Science Exemplar System for Professional*

Development. This program combines Web-delivered professional development units with in-person teacher learning communities to examine how to implement the practices in the NRC *Framework*.^{xvi}

Conclusion

The National Research Council's *Framework for K-12 Science Education* and the *Next Generation Science Standards* offer a foundation for more focused and dynamic K-12 science education. Regardless of where states and districts are in the process of considering or implementing the standards, hands-on, inquiry-based learning and engaging teacher professional development can strengthen students' preparation for college and careers. States involved in the NGSS development process are making great progress towards this end, and others can learn from these important efforts.

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